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ABSTRACT

Variables affecting the legibility of manuscript letters produced by children from preschool through the first two grades are discussed in this literature review. Much of the research cited has as its major goal the identification of treatment conditions and programming regimes that reduce the confusion and training time commonly associated with handwriting instruction. Specific topics focus on research issues, including (1) measurement of manuscript handwriting and research aimed at products versus processes; (2) aspects of grip and posture such as grip topography, pencil diameter, and line rulings; (3) antecedent events such as selection and presentation of letters, types of practice, modeling, and good/bad form discrimination; (4) prompts and rules, including manual guidance, page prompts, verbal rules, and instruction in correct letter sequences; and (5) consequent events (i.e., reinforcement and feedback, formal and informal self-measurement). Special issues discussed involve handwriting readiness, tracing and copying, and reversals, as well as individual differences and individual writing styles as they relate to instruction. (RH)

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Behavior Analysis of Beginning Manuscript Handwriting[1]

by

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Behavior Analysis of Beginning Manuscript Handwriting[1]

In keeping with previous reviews of handwriting (Askov, Otto, & Askov, 1970; Graham & Miller, 1980; Herrick & Okada, 1963; Peck, Askov, & Fairchild, 1980), the present account raises more research questions than it answers. Unlike previous reviews, the questions raised and research reported herein are more circumscribed, dealing largely with variables affecting manuscript letter legibility of children from preschool to the first two grades.

Traditionally, manuscript writing is taught before cursive script. Closely resembling book print, manuscript is composed of simpler strokes, is more readable, and supposedly easier to learn, than cursive writing (Barbe & Lucas, 1974; Jackson, 1970; Townsend, 1951). Additionally, since the individual letter configurations in manuscript words are discrete units rather than strung together as in cursive script, learning to apply letter-by-letter sounding out or decoding strategies in beginning reading (Carnine & Silbert, 1979) would probably be easier given the former instead of the latter script. On the other hand, fewer letter reversals probably result from cursive writing because of the strong left-to-right directional pattern involved in the construction of words, i.e., doubling-back of individual letters is difficult to do.

Achieving a legible manuscript can be an arduous and extremely prolonged process for many children. The scope of much of the research reviewed herein has as its major goal the identification of treatment conditions and programming regimes that will reduce the

confusion and training time commonly associated with handwriting instruction. Emphasis is given to early handwriting training, often beginning before kindergarten, an undertaking which, when coupled with instruction in reading, spelling, and language comprehension, can lead children from poverty level backgrounds to develop written expressive skills not otherwise possible unless writing was one of the trained components (Weisberg, 1982a). The basis for much of the handwriting data collected by the authors stems from an ongoing, year-round preschool project in which educationally at-risk children, starting at age four, were given intensive, direct instruction training in the academic areas of language, reading, and mathematics (Sims & Weisberg, 1982; Weisberg, 1982b).

As an indication of the high levels of expressive skills that can be attained when systematic training and practice in handwriting is begun early and parallel instruction is given in other "language art" areas, consider the following passage (Figure 1) written by a girl in our preschool program for two years, who, at the time, was five months shy of starting first grade.

Insert Figure 1 about here

What to Measure

Measurement of Manuscript Handwriting

Traditionally, handwriting adequacy has been assessed qualitatively by means of informal evaluation (Addy & Wylie, 1973) or formal measurement using legibility scales (Bezzi, 1962; Freeman, 1915). Informal evaluation involves collecting samples of students' copying or "free writing" (writing from memory) which is to be judged for legibility by the teacher (Brueckner & Bond, 1955). Such teacher judgments, if carried out in a holistic or impressionistic fashion, however, often do not provide a reliable index of legibility.

Handwriting or legibility scales are printed charts depicting normative samples or specimens of well-formed letters and strokes for various-aged children as well as age-appropriate writing speeds provided to teachers for judgment of students' writing in terms of the scale norms (Graham & Miller, 1980). Although specifically designed to improve interjudge reliability over that attained using teacher ratings, most scale-based qualitative comparisons are also considered unreliable (Anderson, 1965; Feldt, 1962).

To improve the reliability of the formal evaluation process, recent investigators have employed clear plastic overlays. These grading templates, when placed directly over a written letter, yield an on-target legibility score (Helwig, Johns, Norman, & Cooper, 1978). Overlay evaluation produces very high interscorer agreement, ranging generally from 90-100%, and requires little training for accurate usage (Sims, Weisberg, & Gardepe, 1980).

Although providing objective and reliable scores, overlay-based measurements can fail to correspond to teacher judgments of acceptable legibility. Hence, the validity of an overlay score

can be questioned. Consider the well-formed but smaller-sized letter in Figure 2a.

Insert Figure 2 about here

According to a template scoring procedure, on-target performance would be low, qualifying the letter as unacceptable, whereas teachers might reach the opposite conclusion. On the other hand, the misaligned letter in Figure 2b is perfectly within the error toleration band of the template (on-target 100%), yet its form would hardly meet professional standards of acceptability.

Related to the validity issue is the questionable benefit of a single overall score, such as percent on-target, for purposes of handwriting instruction and remediation. What seems necessary instead are practical measures of handwriting, any one or all of which are helpful in classifying and pinpointing the nature and severity of ongoing handwriting deficiencies and, at the same time, are sensitive to instructional variables. The dimensions of handwriting that commercial publishers (Bowmar/Noble Publishers, 1980; Engelmann & Miller, 1980) frequently cite as critical for manuscript letter evaluation are uniformity of slant, uniformity of alignment, letter height, quality of the line or stroke (waviness) and, if a series of words are to be written, appropriate spacing between letters and words.

In research practice, however, raters of legibility, who are usually experienced teachers, are sometimes not explicitly told what dimensions of handwriting to use as criteria to judge legibility (Sims, Weisberg, & Gardepe, 1980). Rather, it is assumed that the raters, by virtue of having used all of these dimensions to

grade handwriting informally in the classroom, will again refer to each of them when asked to make an overall judgment of letter legibility for research purposes. This assumption is probably gratuitous. Whether any of the criteria are actually utilized is unknown, as is the weight assigned to any single dimension or combination of them.

One advantage of offering known and separate legibility criteria to raters is, of course, the possibility of assessing and improving interobserver reliability. Sound empirical data that order these separate dimensions in terms of reliability would be a much-needed contribution to the handwriting literature. Specific criteria for handwriting evaluation have been employed (Halpin & Halpin, 1976), but the final data are typically cast as a single score that pools judgments across dimensions. Researchers would be advised to analyze separate dimensions not only for their reliability but also for their sensitivity to the independent variable under examination. For example, Sims, Weisberg, and Gardepe (1980) found that the major effect of eliminating "start-ball" prompts on copying letters was a reduction in letter height. That not all experimental variables have a unified and equal impact on all dimensions of legibility is probably known to teachers of handwriting. Having serious trouble writing letters, a child might benefit from particular instruction that corrects for poor alignment but leaves the other dimensions of legibility unaffected. Of course, an instructional practice that improves dimensions other than the one targeted would be welcome information but, unless the prevailing research emphasis of single unit legibility scores changes to the use of multiple scores, that information cannot be

forthcoming.

As handwriting training progresses beyond the early phases in which accuracy of letter formation is emphasized, other dimensions of manuscript writing will need to be employed. For this reason, handwriting research with older children has been done on writing speed (Groff, 1961), appropriate spacing and alignment of words and sentences (Herrick & Okada, 1963; Sajwaj & Risley, 1970), and keeping to margins (Sajwaj & Risley, 1970).

Research Aimed at Products vs. Processes

Researchers typically select as data to be analyzed the end result or product of handwriting. That is, the evaluation of legibility is done long after the handwriting act, usually at a time and place convenient to the researcher. Even though teachers also assess handwriting products, especially when large group instruction and time restrictions leave no other choice, their preference is to monitor and correct the construction of strokes, letters, and words at the moment the children write them. Said differently, the teacher's focus is on the process of writing. From a motivational (and student) viewpoint, immediate and direct feedback given at the time a new skill is being acquired is preferable to delayed feedback on some already completed act that possibly contains erroneous elements.

There is much to be gained from observing what children do when constructing written material. An analysis of the handwriting process can shed light on the nature and frequency of common errors made by beginning writers. Children can get off to a bad start and form poor writing habits for various reasons: they may ignore a sample letter by failing to look at it or by continually blocking it from their view; they may write a letter but begin the initial

stroke at the wrong place relative to the page guidelines; and/or they may start a letter, but before finishing it, go on to write another letter, not necessarily in a left-to-right sequence or in the next line. None of these error patterns will necessarily be detected by an inspection of handwriting products.

Sidman and Stoddard (1967) have documented the importance of keeping the error rate low in naive learners. When errors during acquisition go uncorrected, strong error patterns develop which are resistant to later remediation. What is needed are monitoring procedures that spot error tendencies the moment they occur, not based upon delayed inspection techniques inferred from handwriting products. Moreover, once errors occur, a correction procedure must be instituted immediately with the type of corrective feedback sensitive to the particular kind of error (Carnine & Silbert, 1979). Save for a few exceptions (Sims, 1979; Sims, Weisberg, & Gardepe, 1980; Søvik, 1976), researchers have not gotten into the classroom setting to study variables associated with the handwriting process. This is not the case with the academic areas of reading and mathematics where there is a fairly modest literature on process-related determinants of behavior (Carnine & Silbert, 1979; Goodman, 1976; Silbert, Carnine, & Stein, 1980). As a link to what teachers encounter in the classroom, applied behavior analysis on the handwriting process would appear to be a necessary and worthwhile venture.

Grip and Posture

Pencil Grip Topography

Educators have traditionally considered the way one holds the pencil to be an important determinant of handwriting legibility (Callewaert, 1963; Mendoza, Holt, & Jackson, 1978; Rayek & Nesselroad, 1972). Based on the early work of Judd (1911) and Freeman (1918), a standard pencil grip was adopted, which was assumed to relieve tension and possible cramping. Figure 3 shows the standard grip topography. The pencil or pen is to be held lightly between the thumb and the first two fingers, about an inch from the point.

Insert Figure 3 about here

Kahn (1969) observed a selective sample of pre-adolescent students diagnosed as having vision problems and casually noted that their poor penmanship was marked by non-standard pencil grips. Given the restricted and unique subject sample and the possibility that factors other than pencil grip could have contributed to the handwriting deficiencies of these rather experienced writers, no definite conclusions regarding the role of pencil grip can be made from Kahn's clinical observations. As an initial attempt to establish the relationship between pencil grip and legibility, Sims, Weisberg and Gardepe (1980) collected data from children relatively inexperienced in forming letters. A six category observational code was devised which evaluated each child's grip in terms of tension, distance from the pencil point, number of fingers in contact with the pencil, thumb position, index finger position, and whether the child could clearly see what was being written.[2]

Nine 4½ to 5½ year-old children who had completed the first 50 lessons of the DISTAR I Reading program (Engelmann & Bruner, 1977), in which handwriting was practiced for about 20 minutes per lesson, participated. The sampled letters, a, m, s, e, r, and d represented a good mix of straight and curved letter strokes. A total of 45 grip samples per child were recorded as the children copied these letters for eleven 20-minute sessions spaced over three weeks. The overall mean interobserver agreement was 92% and it ranged from 84% to 96% across the grip categories.

Letter legibility was evaluated by both overlay measurement and a five-point teacher rating system, both of which independently yielded good interobserver agreement. The findings showed that the children could be distinguished by differences in their pencil grip topography, but such variation did not correlate with variation in legibility; in fact, the correlations for both dependent variables were negative, albeit nonsignificant. Concerning adult subjects, Little (1943) simliarly reported no strong relationship between grip and legibility.

Analysis of each grip category indicated that all of the children held the pencil too close to the point with some with their fingers nearly brushing the page. It seems reasonable that moving closer to the point, rather than being inappropriate, is a functional adjustment for beginning writers. Consider for example an artist painting on a canvas. Bold, expressive strokes are executed by holding the paintbrush far from the bristles, so that a small movement effects a large, sweeping arc. The same movement, made while gripping the brush near the bristles, creates a much smaller arc, and is more characteristic of finely controlled

detail work. Likewise, young writers may compensate for their just-developing fine motor control by moving their grip closer to the pencil point.

Regardless of the other elements of their individual grip styles, all children also maintained a clear line-of-sight as they wrote. Being able to see what has been written is probably fundamental to the handwriting act. For this reason, young writers may adopt unusual postures which will endure for a lifetime. That is, when their fingers are very close to the pencil point, they may bend far over the desk to see their fingers. A similar compensation is seen with left-handed writers, who may bend their wrist almost to a right angle while writing. Although posture is typically considered important for good handwriting (Milone & Wasylyk, 1981), supportive data are lacking. It is possible, though, that altering posture may result in the child being unable to see what is being written, resulting in adoption of an alternate nonstandard posture or, conceiveably, less legible writing. Unless the grip or posture is producing noticeable discomfort, the value of altering an already adopted position that is functional in producing good legibility is questionable.

Another interesting finding is that although one might expect naive writers to be somewhat unsure of their grip, perhaps experimenting and changing it until an optimal one is found, the preschoolers consistently used the same grip throughout the study. An index of percent grip stability, computed by taking each child's most frequently occurring grip pattern as a percentage of the total number of grip observations, revealed high intra-

subject consistency, ranging from 87% to 100%. A question for future research is whether children develop a grip style even earlier than the onset of formal handwriting instruction. For example, does experience with pegboards, crayons, paint brushes, and even eating utensils, play a part in the evolution of a grip that will later be applied to handwriting?

Not studied by Sims, Weisberg, and Gardepe (1980) was the role of grip on writing speed. It is possible that the compensatory grip styles used to form an accurate letter (changes in posture, increased tension, proximity to pencil point) would change had directions for speed rather than accuracy been given. Casual observation of more sophisticated writers suggests, however, that even with a speed task, the grip pattern is nonchanging. Research varying the nature of the task and writer experience is certainly warranted.

Should researchers desire to directly manipulate pencil grip, there are several methods available. Rayek and Nesselroad (1972) suggest point-to-point color matching of designated fingers to locations on the pencil. Additionally, there are commercial devices that slip over the pencil, such as Grip-Rite (Hoyle Products, Filmore, California 93015), as well as specially designed frames (Zaner-Bloser, 612 North Park Street, Columbus, Ohio 43216) that ensure certain grip topographies.

Pencil and Paper

Pencil Diameter

The present day standard-size pencil, that is the one most commonly used by adults, is 9/32-inch in diameter. It approximates the size of the steel pen holder (Parker , 1972) used in the schools

in the early 20th century. The steel pen holder in turn approximated the size and shape of the goose quill pen in use for centuries before. Thus, the modern pencil diameter may have been determined more by tradition than by deliberate design (Weisberg, 1982).

Around 1920, many school systems began to use larger than adult-size pencils, which were called "primary" or "beginner's" pencils. Being 13/32-inch in diameter, they were intended for use in kindergarten and first grade. Manufacturers and some educators claimed that these pencils should enable a more comfortable writing style because they involve "easier to control" large muscle movements. According to the prevailing developmental theory (Hurlock, 1942), young children were reputed to have difficulty in coordinating the smaller muscles of the hand and finger. Consider the nondocumented assertion made in 1970 by the Joseph Dixon Crucible Company (Parker , 1972, p. 9):

> "The round 13/32-inch diameter is standard for first year learners, as it is easier for tiny hands to control. This size discourages finger pinching, encourages relaxation of the hand and helps form the writing arch."

There are two problems with the developmental argument that justifies the use of primary pencils. First, it is unclear how use of a pencil of larger diameter engages large muscle movement. Callewaert's (1963) analysis of the anatomy of the hand and its movement during writing suggests the involvement of two types of movement. One is necessary for actual letter formation and is controlled by the smaller finger muscles. The other is movement across the page, which is controlled by larger muscles. Thus, while possibly promoting the larger, across-the-page movement, the

large pencil may make fine detail difficult to achieve. If such is the case, that large diameter pencils inhibit the use of fine dexterity, then their employment would disrupt rather than advance fine motor development (Parker, 1972).

Second, fine muscle control appears to be fairly well advanced before a child enters kindergarten or first grade. One might expect that, if younger children have less fine motor control, they should rely more on larger muscle movements for drawing and writing, and therefore, they should make larger drawings. Studying drawing size of nursery school, kindergarten, and first grade children, Parker (1972) found that, surprisingly, first graders drew larger pictures than either of the other groups. Additionally, the children drew with three different-sized pencils: a beginner's pencil (13/32-inch), a standard adult pencil (10/32-inch), and an even smaller-sized pencil used by stenographers (7/32-inch). A significant effect due to pencil diameter was found only among the children in nursery school and here the relationship between pencil diameter and drawing size was not linear. The stenographer and primary sized pencils produced equally larger drawings than the adult-sized pencil.

Parker's (1972) analysis is not without its problems, however. The size of a drawing may be a poor index of how well the details of the drawings are made. A child may draw a person with a large head and large torso but provide fine detail to the hands and parts of the face. More evidence concerning fine motor ability of beginning writers is clearly needed.

Also, Parker (1972) did not relate pencil diameter to handwriting legibility. One study which did evaluate the effect of different sized pencils on handwriting quality was that of

Wiles (1940). In a three-by-three factorial design, three different pencil diameters (standard adult, primary, and an intermediate one of 11/32-inch) and three different sized line rulings (line spacings of 1-inch, 5/8-inch, and 3/8-inch) were used. Over 800 first graders, assigned to one of the nine subgroups, wrote throughout the school year according to prescribed pencil-page line size combination. Each subgroup copied words from a list compiled from reading and spelling classes. At three different times during the school year, their writing was evaluated according to form, fluency, alignment, spacing, size, slant, and hand pressure exerted. Wiles (1940) found very little relationship between the quality of measured handwriting and the diameter of the writing instrument, and further noted that, "bodily reactions, which sometimes accompany handwriting, such as tension of muscles, facial contortions, twisting bodies, and poor hand-pencil positions, are present as often with one size tool as with another" (Parker, 1972, p.7).

To further evaluate the relationship between pencil diameter and handwriting legibility, Weisberg and Sims (in preparation) tested the manuscript writing of 24 kindergarten children who had some writing experience during school. In a within-subjects counterbalanced design, each child wrote eight lower case letters on a series of six worksheets corresponding to three different sizes of line rulings: a larger than primary ruling size which is the size used at the beginning of one (DISTAR) handwriting program (15/16-inch); primary ruling (5/8-inch); and college ruling (5/16-inch). Half the children wrote on the first three worksheets, presented in random order, with primary pencils; the other half used standard adult pencils for the first three worksheets. Pencil diameter

was then changed for the second three worksheets. Statistical evaluation indicated no major differences in legibility, as measured by teacher ratings, between letters written using the primary and standard adult pencils. Figure 4 typifies the results found, showing sample letters written with each size pencil.

Insert Figure 4 about here

Several considerations argue against the use of oversize writing tools. In addition to being more expensive (generally costing twice as much as a standard pencil) and containing a softer and thicker lead, which is prone to smudging and is difficult to erase, a new primary pencil weighs 10.75 grams, more than twice as much as a new standard pencil (4.5 grams). Its increased weight means that with a center of gravity about 4 inches from the pencil point, the greater weight will make control of the pencil point even more difficult.

Line Rulings

With the introduction of oversized pencils into the schools, there was also a trend toward use of paper with more widely spaced line rulings. Again, the reason for use of oversized rulings was attributed to lack of fine motor control in beginning writers.

As earlier noted, using teacher-rated legibility measures Wiles (1940) was unable to find any differences between words written by first graders on rulings of 1-inch, 5/8-inch, and 3/8-inch, and Weisberg and Sims (in preparation) found no differences between manuscript letters written by kindergarteners on rulings of 15/16-inch, 5/8-inch, and 5/16-inch. Instead, the child's unique style of writing in the Weisberg and Sims study appeared to persist

regardless of ruling size, as demonstrated by the sample letters shown in Figure 5.

Insert Figure 5 about here

Employing a criteria-based rating system, Halpin and Halpin (1976) evaluated the manuscript handwriting of 44 kindergarteners trained for 15 school days using one of four line ruling conditions based on two widths (spacings of 1-inch, ½-inch) and two types of margin control (open and closed margins). No differential effect due to wide versus narrow line spacing on the quality of beginning handwriting was detected. Further, no difference in letter placement position was found between students writing on paper with or without vertical margin guides.

Of note is that the posttest given to all children consisted of copying on narrow-ruled paper with open margins. Two possible explanations for the lack of ruling-dependent differences in writing quality exist. First, it is possible that children practicing letters on wide-ruled paper actually wrote letters smaller than the maximum allowable size as dictated by the rulings. Thus, when presented with narrow rulings, adjustment of letter size to the new rulings was minimized. A second explanation is that children readily adapt the size of their writing to the demands of the page, regardless of the ruling size. It is also not surprising that elimination of the closed margin in the posttest resulted in finding no differences between writing of children trained with open and closed margins. Research on other page prompts (Birch & Lefford, 1977; Sims, Weisberg, & Gardepe, 1980) has shown that an immediate drop in performance accompanies sudden elimination of the prompts.

Leung, Treblas, Hill, and Cooper (1980) observed 62 urban and 71 suburban first graders as they wrote ten lower case manuscript letters which represented different letter families on either 3.4 cm ($1\frac{5}{16}$-inch) or 1.6 cm ($\frac{5}{8}$-inch) wide rulings. Using overlay measurement, both urban and suburban children wrote more correct letter strokes using wide rulings. In a systematic replication involving 32 urban and 35 suburban kindergarteners, as well as 19 urban and 36 suburban first graders, Waggoner, LaNunziata, Hill, and Cooper (1981) found no effect of line rulings of 2.25 cm ($\frac{7}{8}$-inch) versus 1.1 cm ($\frac{7}{16}$-inch) on overlay measured legibility for urban children. However, a significant line ruling effect was detected for suburban students. Waggoner et al. (1981) concluded that a degree of competence in letter formation is necessary to produce control of legibility by ruling size.

One important consideration is that the urban children, who probably came from lower SES homes, evidenced poor handwriting regardless of page size. The poor legibility may represent a floor effect produced by the lower level of academic performance of the urban children. Additionally, it is unclear what size paper these children typically used in their schools. In contrast, the suburban children, who came from higher SES homes, may have had greater access to, and more practice writing with, the more expensive, larger ruled paper.

It is also possible that the overlay measures used in the Leung et al. (1980) and Waggoner et al. (1981) studies may have been more sensitive to letter distortion than the rating methods

used by previous researchers. Worth noting, however, is that the scoring overlays for wide ruled paper allowed a 2 mm ($^{1}/16$-inch) deviation from the model letter, whereas overlays for narrow ruled paper were more stringent, allowing only 1.5 mm ($^{3}/64$-inch) deviation. The differences in measured legibility between wide and narrow rulings may be partly attributed to the overlays used (Hill, Gladden, Porter, & Cooper, in press). Hill et al. found significant differences between overlay scores obtained using 1 mm ($^{1}/32$-inch), 2 mm ($^{1}/16$-inch), and 3 mm ($^{3}/32$-inch) overlays. Nevertheless, significant line ruling effects were also found, regardless of the overlay stringency used, for 31 second graders and 29 third graders.

One possible reason for the differential conclusions concerning the effects of line rulings reached by researchers employing teacher rating systems and those applying overlay measurement is that younger children do not, in fact, have the coordination to write letters to fit the smaller lined paper. Rather, they write letters of adequate legibility when assessed by teacher ratings but their letters are too large for the writing space, extending beyond the provided line rulings. As noted earlier, such letters would be scored as poor by overlay measurement. This explanation, although reasonable, does not entirely suffice, given Weisberg and Sims (in preparation) findings that children with different-sized line rulings tend to adjust the height of written letters to the size of the space provided. Perhaps future research on line rulings will incorporate both teacher-rated and overlay-measured legibility in order to detect any discrepancy between the two evaluative techniques and indicate why such differences occur.

Antecedent Events

Selection and Presentation of Letters

Several criteria must be taken into account in determining the presentation order of manuscript letters. First, since lower-case letters appear more frequently in everyday written usage than upper-case letters, priority should be given to teaching the former. Frequency of written usage should guide the selection of which lower-case letters to introduce first. Frequently occurring, and thus highly functional letters, such as s, a, e, r, and m, might be introduced before more infrequent letters such as q, j, and z (Carnine & Silbert, 1979).

Typical of most handwriting programs is to introduce letters either according to their order of appearance in the alphabet or according to "letter families" (Graham & Miller, 1980), which are letters having similar construction. Not only do these two letter-selection strategies result in scheduling letters without regard to their frequency of written usage, but both present highly similar letter configurations, such as b and d, or a and d, close together in time. Based upon Carnine and Silbert's (1979) analysis of which letter sounds to introduce in a phonetic-based reading program, it could be similarly argued that highly similar letters, particularly those with common component strokes, should be separated in their order of presentation to prevent discrimination problems. For the same reason, it would be undesireable to simultaneously present both the upper and lower case forms of individual letters. If the order of presentation cannot be altered to separate letters similar in appearance, letter orthography can be slightly changed to facilitate response differentiation.

A final guideline for sequencing the order of letters for handwriting instruction is to begin with easier-to-write letters rather than more-difficult ones. Although reading learnability has been established for lower-case letters (Carnine & Silbert, 1979), little is known about the relative difficulty of copying letters. It seems reasonable that the more curved letters might be more difficult to form, but an index of manuscript letter difficulty remains to be empirically validated.

Type of practice

An immediate problem is when to introduce new letters and according to what criteria. The procedure in which new material is not introduced until criterion performance is first achieved with formerly taught material is called the cumulative introduction of stimuli. Teaching six sound-symbol correspondences to preschoolers, Carnine (1978a) compared the presentation of these stimuli cumulatively to an introduction strategy in which the stimuli were introduced one after another regardless of mastery. Students in the cumulative introduction group reached overall criterion performance in significantly fewer trials.

Research on the stringency of criterion performance (Bloom, 1976; Carlson & Minke, 1975; Houser & Trublood, 1975) suggests that setting high levels of mastery results in superior learning. Since evaluation of handwriting quality is based on multiple dimensions of legibility, i.e., size, slant, etc., all should be considered in setting an overall standard of performance.

Once a set of practiced and relatively new letters is selected for a particular session, the arrangement of all the letters on the worksheet must be established. Should the top half of the page be devoted to massed practice of the new letter, and the bottom half to the others, or should practice on the new letter be interspersed with practice on old letters? Although such a comparison has not been made in research on handwriting, distributed or interspersed practice has proven to be more effective than massed practice (Crowder, 1976), particularly in the early stages of learning. Kryzanowski and Carnine (1978) found that an interspersed presentation pattern for teaching sound-symbol correspondences,

although prone to producing more errors during training, resulted in significantly better posttest performance. Interspersed presentation patterns may also be useful in structuring the arrangement of page prompts, with strongly prompted letters interspersed with letters receiving more minimal cues, rather than a series of strongly prompted practice followed in turn by a gradual or sudden elimination of prompts altogether (Hirsch & Niedermeyer, 1973).

Modeling

In setting up a copying task, a model letter is generally provided, either directly on the worksheet or on a bulletin board, blackboard, or overhead projection screen. Research concerning the specific characteristics of an optimal model letter is lacking, but logic dictates some guidelines for model construction.

First, the model letter is probably more effective, at least in the beginning stages of instruction, when presented directly on the worksheet. Not only does proximity facilitate self-checking, but having the model on the page eliminates the "up-and-down" spot checking necessitated by blackboard presentation. A possible side effect of close stimulus-response location is a reduction of off-task behavior.

Second, the model letter should approximate as closely as possible the targeted handwriting response, in size and configuration. Some programs, such as the DISTAR Reading I handwriting program (Engelmann & Bruner, 1977), present thickened, dark model letters which, although highly discriminable and thus desirable for reading instruction, may be inappropriate for handwriting instruction because

it is not possible to duplicate the model in thickness and form with a pencil. After writing a letter, the child is often referred to the model and asked, "Did you make one just like this?" An honest answer, regardless of the quality of the child's writing, would be no. If the model is to serve as a basis for teacher- and later self-correction, it needs to be a valid representation of the target response.

Finally, the position of the model relative to the spaces provided for copying is important. Experience indicates that if a single model letter is presented at the far left side of a worksheet, followed by a number of spaces for copying, handwriting performance declines as the child proceeds across the page. The reason for the decline is unclear, although several possibilities exist:

1. Fatigue
2. The further away the space for copying, the less stimulus control exerted by the model letter.
3. Children may not check each successive letter against the model, but against the last written letter, resulting in an increasingly poorer quality.
4. Children sometimes steady the paper with their left hand, obscuring or completely covering the model letter and preventing its use as a referent.

Research is clearly needed to investigate each of these possibilities so that recommendations for worksheet construction and classroom instruction may be made. Possible remedies include interspersing copying spaces with model letters, or printing model letters directly above the space in which they are to be copied.

Just as seeing a picture of an automobile does not tell you how to build one, providing a model letter does not necessarily imply the correct procedure for letter construction. An alternative to sometimes lengthy verbal descriptions of appropriate behavior is modeling of the process of handwriting rather than just its product. Process modeling has been utilized in two ways: copying after watching the teacher model the act of writing the letter (Hayes, 1982; Sovik, 1976) and copying after watching a "motion model" -- a letter which, through a special procedure, forms itself in the absence of the writer (LaNunziata, 1982; Wright & Wright, 1980). Observing the process of writing has been shown to be more effective in promoting handwriting legibility than "still" (product) modeling and verbal description.

Good-Bad Form Discrimination

Prior to receiving practice on writing letters, the child is often given visual discrimination practice with the letters soon to be written. Discrimination practice has typically involved comparisons between different letters, a procedure that has had little effect on handwriting quality (Hirsch & Niedermeyer, 1973). It is possible, however, to provide visual discriminations between samples of the same letter by presenting good and bad examples of letter construction. Within-letter discriminations would be an effective technique for focusing the learner immediately on the relevant dimensions of legibility (Weisberg, 1982). For example, modeled letters depicting correct and incorrect size, slant, alignment, waviness, and spacing could be shown to the learner, requiring recognition of acceptable forms through simple yes/no questions. Worksheet tasks

could also be constructed which require the student to circle good forms, or cross out bad forms. Whether within-letter discrimination practice will facilitate handwriting legibility remains to be seen.

Prompts and Rules

Manual Guidance

Herrick and Okada (1963) report that many teachers use manual guidance to set the writer on the proper course to execute certain handwriting actions. Used either to prompt correct hand movements in new writers or to overcome poorly formed habits, manual guidance is used to let the writer "feel" what is, at first, not a natural way of doing things. Employed at the very beginning of a handwriting program, a teacher may position the child's hand to demonstrate correct pencil grip, help move the child's pencil to form correct letter strokes, or show the correct direction of travel across the page (Becker, Engelmann, & Thomas, 1975). Physical prompting is quickly discontinued once letter construction comes under the control of other stimuli, such as page prompts, and/or well-practiced verbal rules operating at the overt or covert level.

Page Prompts

A seemingly powerful factor in the control of legibility is the type and frequency of prompts found on most handwriting worksheets. These prompts may vary in degree of stimulus control from a full-stimulus prompt, such as the dotted outline of a letter to be traced, to more minimal cues, such as nothing more than a darkened section on the baseline, or bottom line ruling, signifying a blank space for a letter to be written.

Sims, Weisberg, and Gardepe (1980) evaluated the effect of four different page prompts on handwriting legibility. Four preschool children copied six lower case manuscript letters on worksheets adapted from those used by the DISTAR Reading I (Engelmann & Bruner, 1977) handwriting program. The worksheets presented two rows of practice per letter, with each row including a dark model letter, plus these four prompts: (1) a dotted letter for tracing, (2) a start-ball with a directional stroke to cue both initial placement and direction of each letter stroke, plus a dark underline to ensure proper spacing, (3) a start-ball alone with the dark underline, and (4) a blank space with the dark underline. The two start-ball prompts were sequentially counter-balanced on alternate rows to control for any possible order effects. Overlay evaluation revealed legibility to be significantly affected by the type of prompt provided. Tracing performance was better than writing with a start-ball prompt, and writing with a start-ball was better than writing with a blank space. No difference was found between the two start-ball prompts. Worth noting is that the overall sequence of prompt presentation could have accounted for the decrease in legibility. That is, it could

be that legibility decreases as a child writes progressively farther away from the model letter.

To investigate further the effects of the page prompts, a second study was conducted. Eighteen beginning second graders copied 32 single and four joined (digraph) phonetic letter characters from the DISTAR handwriting program on worksheets which presented the two start-ball prompts and the blank space prompt counterbalanced in an ABCCBA fashion on each row. The dotted letter for tracing was not included in the counterbalancing because tracing and copying appeared to constitute topographically different response categories. Instead, a single tracing prompt was presented in lieu of the dark model letter, to serve simultaneously as a model and to ensure that children had the fine motor control necessary for letter copying.

Both overlay evaluation and teacher ratings were used to measure legibility. Overlay measurement detected significant effects between the start-ball prompts and the blank space prompts, but no differences were found between the two start-ball prompts. Teacher ratings did not detect any significant differences between prompt conditions. The discrepancy between the two measures of legibility suggested that the prompts might be controlling some aspect of handwriting to which the template scoring was sensitive, but which teachers may not consider as critical in judging letter quality, for example, letter height. Using a clear plastic ruler, the height of all letters was determined. A significant difference was found between the height of letters written with start-ball prompts and those written in blank spaces. Thus, the start-ball prompts appeared

to control the height of written letters.

Additional control of letter height is provided by the page rulings. Weisberg and Sims (in preparation) found that children tend to adjust the size of their writing to fit the demands of the line rulings. However, the page rulings may be more functional in controlling the size of some letters more than others (Weisberg, 1982). The page rulings probably also serve to control the alignment of letters, as is evidenced by the upward or downward "drift" obtained using unlined paper.

Also of interest is the role of the dark underline in controlling letter spacing. Although no analysis of the effectiveness of the underline prompt was made in the Sims, Weisberg, and Gardepe (1980) study, Halpin and Halpin (1976) found no effect of vertical lines on letter and word spacing. It seems reasonable that such prompts may not be functional unless specific rules concerning their use are taught. Likewise, verbal rules should enhance the effectiveness of any printed page prompts.

Besides size, spacing, and alignment, page prompts may be used to regulate letter slant. The Engelmann and Miller (1980) cursive handwriting program provides slanted reference lines at the beginning of each row to demonstrate the correct slant for writers beginning the transition from manuscript to cursive writing.

Eventually the writer will be expected to write on adult writing paper with minimal cues, with no more than line rulings available. A plan for the discontinuation of prompts is essential.

Because sudden discontinuation generally results in a considerable decrement of performance, prompting is frequently eliminated gradually through fading techniques. Fading should be phased out as soon as possible to prevent beginning writers from becoming overly prompt-dependent (Becker, Engelmann, & Thomas, 1975).

There are several ways to carry out a fading procedure. Consider the dotted letter prompt for tracing. One fading strategy would be to eliminate the dots systematically, starting with the final dot of the last letter stroke and "receding" to the beginning of the first stroke (Hirsch & Niedermeyer, 1973). Another would be to gradually increase the distance between the dots. A third possibility might be to retain all the dots, but print them in lighter and lighter ink until they disappear (Askov & Greff, 1975). Finally, the full tracing prompt might be increasingly interspersed with blank spaces (Hirsch & Niedermeyer, 1973).

Verbal Rules

At some point in training, external cues that initially helped guide the construction of letters will no longer be present. The question then becomes one of how to place performance under the control of the writer. Studies have shown that fading of external prompts for writing letters (Hirsch & Niedermeyer, 1973) and drawing geometric forms (Birch & Lefford, 1967) does not guarantee correct construction of letters or figures in the absence of these prompts. An alternative approach is to teach explicit rule statements about correct form construction which will become "internalized" or operate at the covert level to control handwriting performance (Robin, Armel, & O'Leary, 1975). For example, given practice in tracing the outline of a d, for which the dotted form represents a source of external control, the child could be taught the rule: "For the letter d, you make the ball part first." It is possible that when later confronted with a blank space and asked to write a d "from memory" (absence of external control), the verbal rule will control handwriting at the covert level (internal stimulus control) and will help prevent confusion with other letters.

Several instructional procedures for teaching handwriting have incorporated verbalization to some extent. Enstrom (1966) taught children to pronounce letters as they were being traced in order to focus attention on what was being traced. Furner (1969a, 1969b, 1970) had students observe adults modeling the correct process of writing while they verbally described in detail the formational procedure. One commercial program, Recipe for

Reading (Traub & Bloom, 1975), makes extensive use of verbal rules, although the rules are often so lengthy and complex as to be of questionable utility for beginning writers with limited language skills. Although Robin et al. (1975) found that letter-specific verbal rules do not readily generalize to untrained letters, rules specifically designed to teach a "general case" (Carnine & Silbert, 1979) have been shown to produce desired generalization.

After observing the sharp change in writing quality which occurred following the discontinuation of start-ball page prompts, which initially controlled placement of letter strokes, Sims (1979) taught beginning second-graders specific verbal rules to control self-placement of the prompts. Self-placement of the start-ball prompt thus represented the first step in establishing self-control of writing manuscript letters.

In the Sims (1979) study, three groups of six children were pretested and found not to know where to place the start-ball, either with respect to the page rulings or even when provided with a dotted sample letter. Next, they received differential training in prompt placement. One group received feedback and contingent reinforcement (Group R) for correct prompt placement. In addition to feedback and reinforcement, a second group (R+M) received a brief modeling demonstration of correct prompt placement by the instructor. Modeling consisted of showing the child a series of correct and incorrect placements with respect to a dotted sample letter. The third group (R+M+R) received the feed-

back, reinforcement, and modeling components of instruction, and were also taught specific verbal rules about prompt placement for each letter. For example, one verbal rule for the letter d was: "The big ball (the start prompt for the initial letter stroke) for the d goes above the dotted line."

The two groups receiving the modeling component immediately evidenced errorless performance, whereas only gradual improvement in prompt placement was characteristic of Group R children. In a series of post-training probes in the absence of the dotted training letter, it was found that correct prompt placement for all groups decreased. Nevertheless, behavior-specific rules produced significantly better prompt placement than reinforcement and modeling. The drop in performance by all groups was not surprising in light of the fact that children received only brief training (the entire training process took less than 20 minutes), and that the letters selected for training (d, b, f, and t) were highly similar and, when introduced at the same time, are likely to produce confusion errors (Carnine & Silbert, 1979). Had the instructional programming been such that the letters were introduced gradually with similar letters separated in time and sufficient cumulative review provided, it is likely that correct prompt placement would have been maintained at a high level. Additional research on the role of verbal rules in mediating various handwriting-related behaviors is clearly merited.

Teaching Correct Letter Sequences

Training the left-to-right sequence of writing letters is important for two reasons. First, it is a necessary skill for arranging letters to form words along the line rulings. Second, correct within-letter sequencing, i.e., the progression from one letter stroke to the next, can be valuable in the construction of well-formed letters. It is possible that teaching the proper sequence of letter strokes will aid in the reduction of reversal errors. For example, some commonly reversed letters having similar configurations, as with b and d, can be more easily differentiated if the sequence for drawing the strokes for these letters is different and that difference is explicitly taught. For the b, the straight stroke, or "stick" part, can be drawn first, and the circular "ball" part drawn next. Conversely, the left-right sequence for the d dictates that the "ball" part be drawn first, and the "stick" part drawn next.

In programs which emphasize repeated copying of model letters with no direct instruction of within-letter sequences, the development of successful strategies for learning to form manuscript letters is left for the child to induce. Leaving the discovery process to the child can unfortunately produce the learning of misrules about correct letter construction, resulting in letter reversals or illegible writing. One possible misrule might be that the child learns to consistently make the "stick" part of any letter first. This sequence misrule, when incorporated into the left-right movement across the page, could possibly lead to letter reversals, as in writing b for d. By providing direct training and logically consistent procedures in the component skills of letter formation, misrules may be avoided, as will numerous errors made by the child.

Consequent Events

Reinforcement and Feedback

Instructional programs for manuscript handwriting generally include some combination of external source of contingent consequences delivered upon either rate of writing or making legible letters. These consequences have taken various forms. Fauke Burnett, Powers, and Sulzer-Azaroff (1973) used a combination of candy reinforcers and teacher praise with an educationally at-risk child to increase manuscript letter labeling and copying, both with and without a printed model letter. Lahey (1977) demonstrated improved copying by children diagnosed as learning disabled as a result of contingent reinforcement and corrective feedback.

Access to a playroom has effectively increased the rate of copying manuscript letters by both first and second graders (Hopkins, Schutte, & Garton, 1971). However, with respect to legibility, considerable error variability was observed, and although there was a steady trend toward fewer errors with training, no clear effect due to the contingencies was evident. That legibility was unaffected is not surprising since access to the playroom was decidedly not dependent upon legibility. That is, children were told the sooner they finished, the sooner they could go play. No conditional statement about the quality of their work was made. In another study by Salzberg, Wheeler, Devar, and Hopkins (1971), intermittant access to play contingent upon the legibility of copied letters did improve the accuracy of letter formation.

Two studies (Brigham, Finfrock, Breunig, & Bushell, 1972; Miller & Schneider, 1970) have used token systems to improve handwriting. In Miller and Schneider's (1970) program, contingent tokens, redeemable for snacks and access to play activities, were found to improve the rate and accuracy of writing letter-like strokes by Head Start children. Using the same handwriting program as Miller and Schneider (1970), Brigham et al. (1972) found that contingent token delivery paired with praise produced better writing responses, as judged by criteria-based teacher ratings, than noncontingent token and praise delivery.

Immediate and consistent feedback would seem to be an important component of any instructional package. Feedback may be provided by an external source, such as the teacher, or by the direct physical impact of some aspect of the handwriting act. Regarding the latter type, Skinner and Krakower (1968) devised a specially treated worksheet which contained invisible error bands for each letter. Whenever the writer's strokes made by a stylus appropriately stayed within the error bands, it produced a distinct color on the paper and whenever the strokes fell outside this band a different color appeared. Similarly, Parker (1975) devised a photo-electric pen which provided differential visual and auditory feedback for on- versus off-target writing responses.

Another technique for delivering immediate feedback is through self-recording. By providing each student with a clear plastic evaluative overlay, Johns, Porter, and Cooper (in press) used feedback from self-

measurement of letter accuracy in combination with public charting of performance. A group contingency criteria, adopted from Hamblin, Hathaway, and Wodarski (1971) was used, in which the entire class received reinforcement if the three writers with the lowest mean scores across the first four handwriting sessions met criterion performance. The number of correct letter strokes drawn by the entire class increased as a function of the reinforcement package.

In a typical classroom, handwriting instruction may not follow a rigid arrangement of antecedent and consequent events, but rather consist of a complex mixture of prompts, corrections and rewards. To study such complex classroom interactions, Sims et al. (1980) devised a coding system to monitor teacher behaviors during handwriting instruction (see Table 1). In an ABAB

Insert Table 1 about here

design, four preschool children practiced writing manuscript letters as the teacher either interacted in her normal teaching style or refrained from giving any attention by doing busywork. Independent checks verified that the teacher kept to those attention-nonattention practices. Nevertheless, handwriting legibility, as measured using both teacher ratings and overlay evaluation, was unaffected by differential teacher interaction. At first glance, the noneffect of teacher interaction may seem puzzling, although Salzberg et al. (1971) also found that instructions in the absence of both feedback and reinforcement (access to play activities) produced relatively poor handwriting performance, and that adding feedback by itself was insufficient to improve performance level.

The failure of teacher attention to influence letter legibility may be attributed to two factors. The first is that typical teacher comments such as those provided to children in the Sims et al. (1980) and Salzberg et al. (1971) studies may not be informative enough to help in the process of letter construction. The statement, "That is a good m," does not tell the student what it is about the m that is "good." The more specific statement, "I like the way the humps of this m touch the top line," is much more informative, but represents a degree of specificity rarely found in the classroom.

Second, the children in Sims et al. (1980), having completed 50 lessons of handwriting prior to the study, could have become instructionally sophisticated enough to write letters by following the page prompts on their handwriting worksheets, such as rulings and the prompts for starting position and letter spacing. Possibly, the major impact of the teacher as a provider of information was limited to these early lessons, during which critical instruction and monitoring in the appropriate use of these page prompts was given. Once handwriting was under the control of these prompts, the teacher's role lessened. This does not mean that the teacher is without further potential influence. As earlier mentioned, the teacher needs to provide simple, but specific, feedback about the starting position, stroke quality, and so forth.

Formal and Informal Self-Measurement

One important factor in bringing handwriting responses under self-control is teaching students to evaluate and edit their own work. The results of two studies (Johns, Trap, & Cooper, 1977; Johns et al., in press) have demonstrated that training students in the formal overlay evaluation of their own manuscript letters improved letter stroke formation.

Besides formal self-measurement, an informal self-checking procedure might be useful in maintaining legibility. Comparison of just-written letters to well-formed models is analogous to a matching-to-sample task (Sidman & Kirk, 1974), in which performance has been shown to improve as a result of training in scanning strategies, i.e., comparing stimuli on the basis of specific criteria (Egeland, 1974). For example, students could be taught to evaluate written letters on the basis of correct size by "matching" the letter to the model and asking (covertly or overtly), "Is the one I drew the same size as this one?" Similarly, scanning strategies could be devised for each of the legibility criteria employed by the handwriting teacher.

Special Issues

Handwriting Readiness

Graham and Miller (1980) assert that prior to formal handwriting instruction, a child should evidence an assortment of abilities and skills; in short, the child must be "ready to write." The concept of handwriting readiness can be divided into three separate approaches: waiting for skills to develop (maturational), the development of general psychological processes through readiness activities, and direct instruction in the skills essential for writing manuscript letters.

From the maturational perspective, handwriting skills develop according to a time scale in much the same way as the child develops the musculature and eye-hand coordination to pick up small objects. In this time-linked view, adequate physical development is a necessary prerequisite for handwriting (Anderson, 1972). Instructionally speaking, this perspective has little more to say than "wait until handwriting happens."

In the second approach, there are assumed to be general processes or abilities which underlie the development of manuscript writing. Frequently mentioned processes are perceptual-motor coordination, directionality, visual discrimination, spatial ability, and the like. Practice in tasks that allow the expression and development of these processes are sought, with the nature and features of the selected tasks not necessarily showing a direct link to the actual construction of manuscript letters. In fact, specific training started in letter writing as soon as the child can control a pencil is often viewed as trivial, counter-productive, and to be avoided unless preceded by tasks that strengthen general abilities.

The selection and implementation of readiness activities for

handwriting are closely aligned with the general process viewpoint, or what Gerard and Junkala (1980) have called "process-based instruction." As expected, the readiness activities should be diverse and multi-sensory based. For example, children are encouraged to trace large letters not only in the air but on the floor, on someone's back, on sandpaper, while fingerpainting, and during some activities with their eyes shut (Green, 1967; Shea, 1956; Traub & Bloom, 1975). These and other "preparatory" activities are so well entrenched in the preschool and primary grade classroom, and are given periodic testimonial support in the form of descriptive accounts on how to expand and enliven them (e.g., Peterson, 1975; Towle, 1978; Wright & Allen, 1975), that the activities are uncritically accepted and defended as the precursors and facilitators of handwriting performance. Yet, not a single experimental study is cited in reviews of handwriting (Askov et al., 1970; Peck et al., 1980) in which there are empirically based comparisons on the merits of particular readiness activities relative to direct manuscript training sans readiness. As will be documented later, the limited evidence on the value of two readiness activities (tracing and visual discrimination training) has shown that they either do not facilitate subsequent manuscript letter copying or they worsen it when compared to a copying-first condition. Some researchers (Hammill, 1972; Stephens, 1977) consider process-based instruction to be of dubious value and Gerard and Junkala (1980) note its failure to demonstrate substantial academic gain.

Probably the major scientific support for readiness activities is that performance on many of them is moderately correlated with handwriting legibility. Although this does not imply a cause-and-

effect relationship, it does have some impact on teachers who see that many of the children doing well on tracing geometric patterns, color recognition tasks,understanding verbal concepts relating to direction, spatial location, and so on, are the same ones who later write letters legibly. Also, because of the multitude of activities that make up a readiness battery, there is the possibility that some items do indeed engender prerequisite skills for writing. As an instructional practice, this shot-gun approach is obviously inefficient and can only serve to delay handwriting training of some children failing to show overall proficiency in the myriad tasks.

The goal of direct instruction approaches is to select, sequence, and integrate the essential component skills for writing and actively teach them in the most efficient manner. As laudable as this sounds, there is not much agreement among designers on the sequence for letter presentation and what form their initial orthography should take. As mentioned earlier, there is considerable design variation with respect to several important programming features: the scheduling of upper and lower case letters (presenting them in a paired sequence vs. a lower case followed by an upper case sequence); the criterion for the order of letter introduction (the alphabet, similarity of letter strokes, frequency of usage in words, or the order used to introduce letter sounds in a companion reading program); and letter orthography (ball-stick letters, modified cursive, or a modified manuscript in which some letters are exaggerated in form or joined to others to heighten letter-sound discriminations).

Given such variation, designers of different handwriting programs are bound to have a different set of assumptions as to what are the essential skills for handwriting and how they should be taught. The question of what prerequisite skills to teach translates into "prerequisite for what purpose?" Designers employing a large set of verbal concepts in the instructional process (around, at the middle, beginning, ending, slant, loop down, swing out) will need to develop tasks that effectively teach these verbal concepts as well as the operations they represent. Other designers that make greater use of page prompts or teacher modeling techniques and rely less heavily on verbal cues to control handwriting progress will have different views about the importance of verbal prerequisite skills. So, too, will the nature and layout of different worksheets dictate the kinds of prerequistire skills to emphasize. For some, tracing activities will be critical; for others, a copying-first procedure might be more important.

The diversity of reading programs readily show a different mix of assumptions about the reading process and what skills are necessary (Carnine & Silbert, 1979). The situation is apparently no different for the handwriting process. However, in the case of reading, there is already a vast literature on the overall effects of entire programs and an even greater literature on the effects of different component skills. A parallel literature needs to be developed for manuscript writing.

Tracing and Copying

A traditional and common readiness activity is tracing practice. Dotted sample letters comprise the major stimulus, although many tracing activities involve a host of other visual forms. Even though most instructional programs rely on copying as the major vehicle by which children develop handwriting skills (Hirsch & Niedermeyer, 1973), Askov et al. (1970) suggested that, in light of a study done by Birch and Lefford (1967), a tracing procedure might be more appropriate for young children.

In the Birch and Lefford (1967) study, children between the ages of five and eleven were taught to draw various geometric forms, aided by visual models and differing levels of stimulus support, ranging from a full-stimulus tracing prompt to a blank space for copying. Drawing performance was shown to decline with the removal of stimulus support. That is, tracing was more accurately executed than copying irrespective of the age of the child, but the difference in drawing performance between levels of stimulus support was greatest for younger children. Based on these results, tracing letters would seem to be easier than copying, and thus more appropriate for young writers.

Hirsch and Niedermeyer (1973) questioned the use of tracing as opposed to copying, pointing out that children, "must eventually be able to form letters without any stimulus support (p. 81)." If tracing is to be taught at all, they reasoned that a gradual fading process would be necessitated. With this consideration in mind, a two-by-two factorial was designed in which 60 kindergarten children received copying or faded tracing practice, either with or without between-letter discrimination training, over 40 sessions lasting

20 to 25 minutes each. Copying was found to produce significantly better letter formation on a posttest than faded tracing, regardless of whether letter discrimination practice was given.

Also using kindergarteners, Askov and Greff (1975) compared practice in copying to a faded tracing procedure, and used shorthand symbols to control for any prior learning of manuscript letters. Once again, copying practice produced superior performance on a posstest of shorthand symbol formation.

Hirsch and Niedermeyer (1973) casually noted that the behavior of the children was noticeably different when tracing than when copying. Given a full-stimulus tracing prompt, short, discontinuous strokes were frequently used to connect the dots of the letter. Since the dots were gradually faded in a backwards fashion, the students ended their strokes with the last dot provided and, thus, did not complete the entire letter. It appears, then, that tracing and copying might constitute functionally as well as topographically different response classes.

To investigate the difference between copying and tracing responses, Weisberg and Sims (in preparation) had preschoolers complete specialized worksheets which provided opportunities for tracing and copying letters. Full-stimulus tracing prompts were printed in blue ink which does not reproduce photographically. Worksheets could then be reproduced, and the writing examined in the absence of the prompts. As shown by the sample worksheet in Figure 6, traced letters were written in a jagged, noncontinuous fashion.

Insert Figure 6 about here

A second pair of worksheets were constructed, one of which

presented a series of 12 manuscript letters to be traced, then copied. The other required copying before tracing. Twenty-four kindergarten children were given both worksheets to complete in a counterbalanced sequence to control for fatigue and order effects. Measuring the time required to complete each row, tracing was found to consistently take significantly more time than copying.

Given the difference between tracing and copying responses, it is not surprising that copying has been found to be a more effective method of handwriting instruction. Kirk (1980) has suggested that, "tracing might well be eliminated as a preliminary step (p. 33)."

Reversals

One developmental consideration worthy of note is the possible relationship of the development of object constancy to reversal errors in letter discrimination and construction. Moyer and Newcomer (1977) point out that letters are among the few objects in a child's world whose identity or value change with altered orientation. For example, common objects such as furniture, animals, toys, and the like are readily identified as the same objects regardless of which way they face the observer. However, using this same rule does not apply to letters: a letter reversed or changed in orientation is no longer called by the same name. Letters (along with numerals) represent an exception to the general concept of object constancy. Moyer and Newcomer (1977) entertain the notion that the development of object constancy might increase the probability of reversal errors as an unexpected side effect. They propose extensive between-letter discrimination training as a remedy for reversals. So far the literature has not demonstrated any benefit of between-letter discrimination for minimizing reversals.

Inappropriate correction procedures and inefficient instruction may inadvertently perpetuate or even aggravate the reversal problem. Two examples serve to illustrate this possibility. The first inappropriate correction occurs when a reversed letter resembles another letter, as in the case of b and d. Upon encountering a reversed b, a teacher is likely to correct the child by saying something like, "No, you made a d. I want you to make a b." Immediately, the already-confused child has not one, but two, simultaneous concepts with which to deal. Carnine (1978b) demonstrated

that a more effective correction would be to say, "No, that (indicating the erroneous letter) is not a b." Thus, the reversed letter is treated as a negative instance of the target concept, and not as a positive instance of a second, perhaps irrelevant concept.

The second inappropriate correction occurs when a reversed letter does not form another letter, as in the case of a reversed s. A commonly heard correction in this situation would be, "Yes, you made an s, but you made it backwards." The backwardness of the letter may be very apparent to the teacher, but the concept "backwards" is a complex one, and many beginning writers do not know what "backwards" means, nor do they know what to do when asked to write backwards letters. If the child does not know the meaning of "backwards," the above correction might as well have been, "Yes, you made an s, but you made it jehfnelxzpt." What the child did understand was "yes", and the rest was gibberish. Again, a more appropriate correction would be to simply refer to the reversed s, and tell the child "That is not an s." Corrections that are clear, simple and consistent may serve to reduce the frequency of reversals.

Individual Differences, Individual Writing Styles and Instruction

One reason for the diversity among handwriting programs is the frequent invocation of the concept of "individuality of the writer." Graphological or detailed handwriting analysis (Bunker, 1966; Solomon, 1980), regardless of its questionable validity, easily reveals that individuals are marked by their personal styles, as is evidenced by the differences found among individuals' written signatures. An assumption stemming from graphological research is that idiosyncratic handwriting patterns are somehow related to unique personality variables, and that these habitual patterns are products of some inner nonspecifiable entity (Coughlin, 1960). Johnson (1942) warned that, " all instruction in handwriting should recognize the fact that learning to write is a highly individual matter," and teachers are cautioned that they should not yield to the "desire to produce uniform results in a group of children (p. 93)."

To avoid the development of negative personality traits, because of "forced" handwriting procedures, programs for teaching handwriting were typically designed to be quite vague. Indeed, the most common practice of early handwriting instruction has been to present the child with the opportunity to practice copying model letters (Hirsch & Niedermeyer, 1973). Since copying was thought to preserve individual styles, or to decrease uniformity of letter writing between children, this loose method of training became the established practice among handwriting teachers, and variation in children's writing was probably encouraged.

The emphasis on individuality and the personal link between handwriting and personality variables has led to the dogma that

poor handwriting by some children is "an almost inborn deficiency which no amount of extra practice or instruction could improve (Westerman, 1971; p. 75)." In contrast, LaNunziata (1982, p.14) has asserted that "we cannot fault the student for poor penmanship skills, for most children are eager and able to learn to write." Additionally, Harris (1960) rejects the view of variation in some inner entity as a cause of poor handwriting since variation in legibility has not been found to relate strongly to variation in such factors as eye-hand coordination, age, race, or intelligence. Milone and Wasylyk (1981) state that, "the critical ingredient in handwriting success is instruction; it can overcome physical and mental disability, social disadvantages, and other factors that often impede educational progress. The best handwriting is found among students in classes in which handwriting is taught (p. 58)." Similarly, Graham and Miller (1980) state that, "most handwriting difficulties are the result of inadequate instruction (p. 1)."

If more direct instruction of handwriting skills is provided, exacting more uniform writing from students, will this destroy the individual differences observed among adult writers? Probably not. Researchers have suggested that the development of a personal style of handwriting is a result of the increased speed with which adults write (Harris & Rarick, 1959; Quint, 1958; Seifert, 1959).

Once a student reaches the fifth or sixth grade, the primary emphasis of handwriting instruction has shifted away from writing quality; teachers, instructional programs, and research tend to focus more on writing speed (Herrick & Okada, 1963). As

speed becomes more and more important, students begin to take idiosyncratic shortcuts in letter formations (Graham & Miller, 1980), resulting in a personal style.

Lindsley (1980) offers an interesting insight into the role of writing speed on the acquisition of an individual writing style. If you write your signature very slowly (about 1mm/sec), surprisingly the signature bears a remarkable similarity to that written when you were in the fifth grade. Perhaps writing rate, rather than personality, determines to a great extent our individual style of writing.

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Footnotes

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[2] Detailed information about the composition of the pencil grip categories and the legibility overlay is available from the first author.

Table 1
Classification of Teacher Interaction

Behavior Category	Description	Sample Behavior
Prompts		
Letter-specific	Refers to letter formation	"Make a straight line."
Sequence	Refers to child's writing sequence	"Go to the next row."
Letter-naming	Checks child on what to write	"What letter are you writing?"
General task	Encourages task completion	"Let's get to work."
Corrections		
Letter-specific	Refers to letter formation	"That's not how you make an s."
Sequence	Refers to child's writing sequence	"You didn't finish this row."
Erasing	Refers to child's erasing	"You are erasing too much."
Grip	Refers to child's pencil grip	"Don't hold your pencil like that."
Rewards		
Letter-specific	Refers to letter formation	"You started in the right place."
Sequence	Refers to child's writing sequence	"Good going to the next row."
General	Any nonspecific rewards	"Good work."
Handbacks	Teacher returns paper for correction	

Figure Captions

Figure 1. Original story written by a 5 year, 10 month girl in a preschool program for almost two years (Jason is a classmate and Kathryn is her teacher).

Figure 2. Difficulties arising from overlay measurement: (a) well-formed letter scored as incorrect due to reduced size; and (b) misaligned letter scored as acceptable.

Figure 3. Standard pencil grip topography.

Figure 4. Sample handwriting record of a beginning kindergarten writer using: (a) a primary pencil; and (b) a standard pencil.

Figure 5. Sample letters drawn by a beginning writer on three different line rulings: (a) larger than primary; (b) primary; and (c) college-ruled.

Figure 6. Sample handwriting record of a beginning writer showing traced (T) and freehand-written (F) letters.

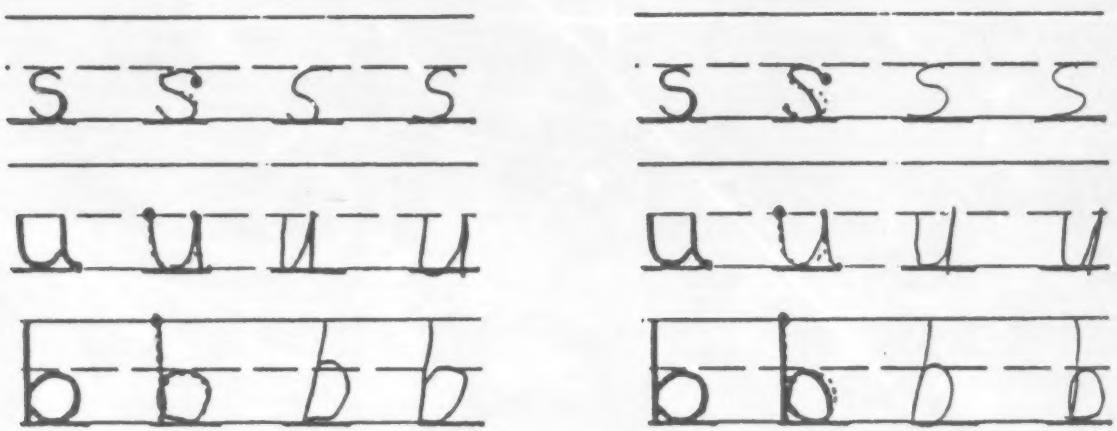
I wish I was a dancer or a sanger but I wish I was a real dancer so I can have a pretty red discoe dress on and I can dans with sombody that is going to be six just like I am going to be. and it mabe is going to be a boy named jason, but. I do not know if it is going to be him. and kaTHRan is going sāy who. jāson, mabe jason. and I am going to wear glass slippers and me and [redacted] jason is going to dans very very sharp. the end

Figure 1

(a) (b)

Figure 2

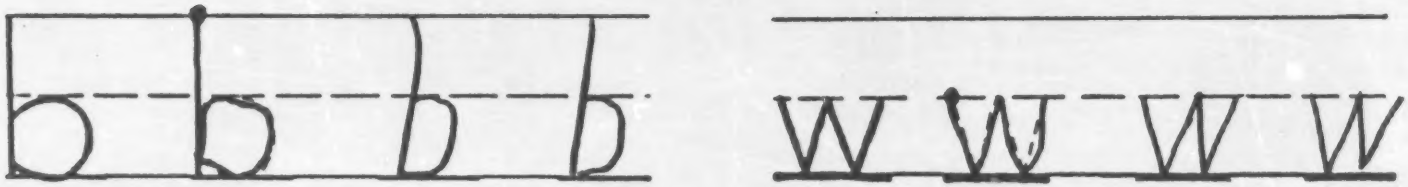
Figure 3



(a) (b)

Figure 4

(a)



(b)

(c)

Figure 5

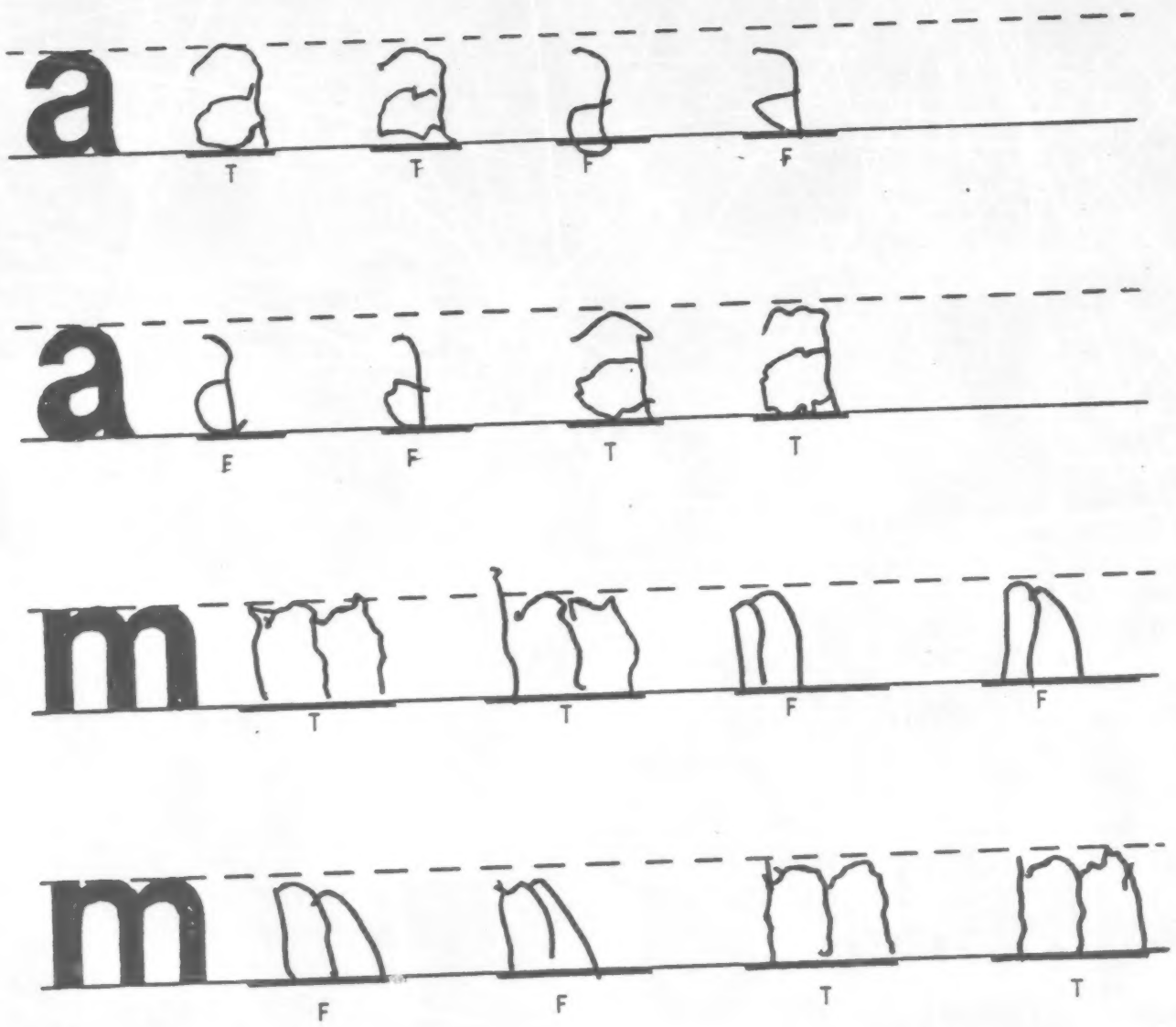


Figure 6